WHAT IS CLAIMED IS:

1. A method of designing a magnetic field gradient coil assembly using tightly wound inner and outer coils, said method comprising the steps of:

setting or resetting the number of said inner coils and optimizing their positions such that a resulting magnetic field strength falls within a tolerable range of a target magnetic field gradient under shielded conditions;

setting or resetting the number of said outer coils and the number of turns of each outer coil;

calculating Fourier components of an electric current distribution necessary for the outer coils;

optimizing positions of the outer coils to approximate the Fourier components of the current distribution;

calculating magnetic fields leaking from the inner and outer coils, respectively;

calculating magnetic field distortions caused by eddy currents produced by the leaking magnetic fields; and

resetting the number of the outer coils and the number of turns of each outer coil if the magnetic field distortions are outside the tolerable range.

2. A method of designing a magnetic field gradient coil assembly as set forth in claim 1, wherein said step of setting or resetting the number of said inner coils and optimizing their positions such that a resulting magnetic field strength falls within a tolerable range of a target magnetic field gradient under shielded conditions uses a Green function.

3. A method of designing a magnetic field gradient coil assembly as set forth in claim 1, wherein said step of calculating Fourier components of an electric current distribution necessary for the outer coils uses a Green function.

4. A method of designing a magnetic field gradient coil assembly as set forth in claim 1, wherein said step of optimizing the positions of the outer coils to approximate the Fourier components of the current distribution performs the approximation using a small number of tightly wound coils.

5. A method of designing a magnetic field gradient coil assembly as set forth in claim 1, wherein said step of calculating magnetic fields leaking from the inner and outer coils, respectively, and said step of calculating magnetic field distortions caused by eddy currents produced by the leaking magnetic fields use a Green function.

6. A method of designing a magnetic field gradient coil assembly as set forth in claim 1, wherein said step of resetting the number of the outer coils and the number of turns of each outer coil if the magnetic field distortions are outside the tolerable range, said step of calculating Fourier components of an electric current distribution necessary for the outer coils, said step of optimizing the positions of the outer coils to approximate the Fourier components of the current distribution, said step of calculating magnetic fields leaking from the inner and outer coils, respectively, and said step of calculating magnetic field distortions caused by eddy currents produced by the leaking magnetic fields are repeatedly carried out to determine optimum conditions for the outer coils by trial and error.

7. A magnetic field gradient coil assembly having tightly wound inner and outer coils, said magnetic field gradient coil assembly having been designed by a method comprising the steps of:

setting or resetting the number of said inner coils and the number of turns of each inner coil and optimizing their positions such that a resulting magnetic field strength falls within a tolerable range of a target magnetic field gradient under shielded conditions;

setting the number of said outer coils and the number of turns of each outer coil;

calculating Fourier components of an electric current distribution necessary for the outer coils;

optimizing positions of the outer coils to approximate the Fourier components of the current distribution;

calculating magnetic fields leaking from the inner and outer coils, respectively; and

resetting the number of the outer coils and the number of turns of each outer coil if the magnetic field distortions are outside the tolerable range.

8. The magnetic field gradient coil assembly of claim 7, wherein said step of setting or resetting the number of said inner coils and optimizing their positions such that a resulting magnetic field strength falls within a tolerable range of a target magnetic field gradient under shielded conditions uses a Green function.

9. The magnetic field gradient coil assembly of claim 7, wherein said step of calculating Fourier components of an electric current distribution necessary for the outer coils uses a Green function.

10. The magnetic field gradient coil assembly of claim 7, wherein said step of optimizing the positions of the outer coils to approximate the Fourier components of the current distribution performs the approximation using a small number of tightly wound coils.

11. The magnetic field gradient coil assembly of claim 7, wherein said step of calculating magnetic fields leaking from the inner and outer coils, respectively, and said step of calculating magnetic field distortions caused by eddy currents produced by the leaking magnetic fields use a Green function.

12. The magnetic field gradient coil assembly of claim 7, wherein said step of resetting the number of the outer coils and the number of turns of each outer coil if the magnetic field distortions are outside the tolerable range, said step of calculating Fourier components of an electric current distribution necessary for the outer coils, said step of optimizing the positions of the outer coils to approximate the Fourier components of the current distribution, said step of calculating magnetic fields leaking from the inner and outer coils, respectively, and said step of calculating magnetic field distortions caused by eddy currents produced by the leaking magnetic fields are repeatedly carried out to determine optimum conditions for the outer coils by trial and error.